Fermi National Accelerator Laboratory

TM-1514

Argon Spill Test for E706

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There were three different tests involved in this series. It should be stated that the purpose of the test was to determine if there should be extra precautions taken with the calorimeter vent stack. No attempt was made to do quantitative measurements. The three types of tests were diffusion tests, spills at a remote site, and a spill at the MW building. Oxygen monitors used were the standard Energy Saver type throughout.

Diffusion Tests

The diffusion tests were done in Lab A. For the tests, two pipes were made with a cover and a 1/2 inch pipe entrance at the bottom. An 8-inch pipe 7-1/2 feet long and a 6-inch pipe 20 feet long were used. Both pipes stood on end with oxygen monitors placed at various levels in the pipe. Argon was added to the pipe by two different methods. In the first test, liquid argon was poured into the bottom of the pipe. Stripcharts taken began when the liquid was poured in. The tests on both pipes show that, with liquid in the pipe, the air is completely displaced. Diffusion of air back into the pipe can take many hours. One test using the 6-inch pipe started with 10% at 6 feet from the bottom at 3 PM was still only at 10.4% at 9 AM the next day. This test was repeated several times with the same results. The equipment was sensitive enough that opening the high bay door showed up on the charts.

The next test was to put a known quantity of argon gas in the pipe. For this test, the 8-inch pipe was used with a cardboard top. The top had two ports in it that allowed the argon to enter while the air escaped. The recorder was started before the warm argon was added (1.6 ft^3). The test shows that the argon mixes essentially immediately throughout the volume of the pipe. Five monitors were used in the pipe and a sixth was in the vent tube as a check. A repeat test showed the same result.

The diffusion tests demonstrated that confined or dense argon can pose a serious oxygen deficiency hazard. If the argon is vented high and allowed to fall through the air, it will mix well and may lessen the ODH hazard.

Remote Spill Tests

The remote test was conducted at the railhead to investigate the behavior of cold argon dumped from a stack. Liquid or cold gaseous argon was provided from a rented Air Products standard customer station dewar. The dewar was equipped with a small vaporizer for increasing the tank pressure and a large vaporizer to supply ambient temperature gas at a maximum rate of 25,000 scfh. The tank also had 1-1/2″ top and bottom fill lines that were connected to the 6″ test stack venting 20 feet in the air. The tanker arrived with 31,120 lbs. of argon. If the E706 LAC relief lifts and fails open about 60,000 scf of argon is vaporized as the vessel depressurizes from 7 psig to atmosphere. For this test, it was planned to release about 25,000 scf as a small spill.

The valve in the tanker was much smaller than the relief valve for the LAC. Figure 1 shows the flow rate from the test valve and Figure 2 shows the flow rate of the relief for the LAC. None of the tests were able to duplicate the expected venting from the LAC in quantity or flow rate.

During the spills, a variety of instrumentation was used. Five oxygen monitors were recorded on a chart. Firemen in Scott air packs were operating the tank valve and taking readings during the actual spill with portable monitors. Smoke bombs and a fire were used to monitor wind direction and influence. A handheld anemometer was used to measure wind speed. Tank gauges measured the amount of the spilled argon. The test was video taped. Figure 3 shows the location of the oxygen detectors for the test. During the entire test the wind speed was measured to be less than 3 M/sec.

In the first spill, the tank was depressurized from 70 psig (45 psig vapor pressure estimated) to 15 psig. The oxygen detectors saw no argon at ground level and the firemen scanned the entire area downstream of the stack and also saw no argon. Figure 4 is an Air Products chart used as a check on the level gauge for the tank. From the chart, one would expect that 5% of the tank contents would have been vented or 134 gallons. The truck level gauge measured 126 gallons vented.

Since there appeared to be no problem with a vapor spill of that size, it was decided to try dumping liquid for a test. In Figure 3 drawing, Test 2 shows the new position of the oxygen detectors. This spill was to be about 150 gallons. The test was stopped after 83 gallons, as measured on the gauge. In the spill, the liquid overflowed the stack, running down the sides of the pipe. The vapor cloud on the ground showed a classic dense gas cloud pattern of gravity spreading. The cloud could easily move against the wind that was blowing. Air mixing by entrainment of air was evident in the cloud of vapor. Both the fixed detectors and the firemen measured decreased levels of oxygen two feet above the cloud and oxygen levels of 16% in the cloud on the ground.

After these tests, the tank was moved to the east side of the MW building. During the move, the tank was weighed at the scale to measure the actual amount of liquid used. The scale showed a weight of 29320 lbs., or 154 gallons, of liquid. It is not clear why the material balance is not better. Differential pressure gauges are often in error by an amount like this, but the measurement compared favorable with the chart for depressuring a tank. Different tractors were used to weigh the tank, so an error there is possible.

The conclusion drawn from this series of tests is that even cold vapor vented high in the air (greater than 20 feet) seems to mix well enough to dissipate without causing an ODH problem. Copies of the recorder for these tests are at the end of this paper, and the video tape is available for review by interested parties.

MW Building Spill

The spill at MW was done in the same manner as the test at the railhead. The stack was raised to 26 feet high to match the height the vent for the LAC will exit the building. Michael Hiza from NBS offered several suggestion for this test.

1. Two video cameras were used.
2. Each of the oxygen monitors had a thermocouple with it.
3. One oxygen monitor was placed 20 feet in the air downstream of the vent stack.
4. Oxygen detectors were placed in the adjacent service building and in MW lab next to the large ventilator.

At the start of the test, the weather was threatening, but it appeared that the test could be done. Wind was measured at gusts of 3 M/sec. After the last of the support units arrived to do the test, it started to rain. The test went on as planned, but the rain got heavier. Several of the oxygen detectors quit working from water damage. Neither detector inside the buildings showed argon at any time. The tank pressure was 147 psig (vapor pressure 125 psig), and the plan was to vent down to 10 psig. This would produce about 60,000 scfh to simulate the real venting condition. In the test, the actual spill was only about 19,000 scfh.

No change was seen in any of the thermocouples or any of the working oxygen monitors. The vapor was dispersed in the air without the cloud coming to the ground. The conclusion reached is that it is not necessary to run the E706 vent to the top of the beamstop hill or to the east or west. Also, no elaborate air mixing scheme will be needed to safely vent the LAC. The video tape of this test is also available for viewing.

Acknowledgements

I would like to acknowledge the help received on these tests from the safety panel for E706: Bill Cooper, Stan Stoy, and Bob Scherr. The Bubble Chamber supplied all of the technical support for the job, particularly the guys in the E. T. shop for getting the monitors and recorders going. I would also like to thank the Fermilab Fire Department, and particularly Firemen Steve Lustig and John Babinec, for their help in doing these tests. These tests were conducted in the summer of 1986.

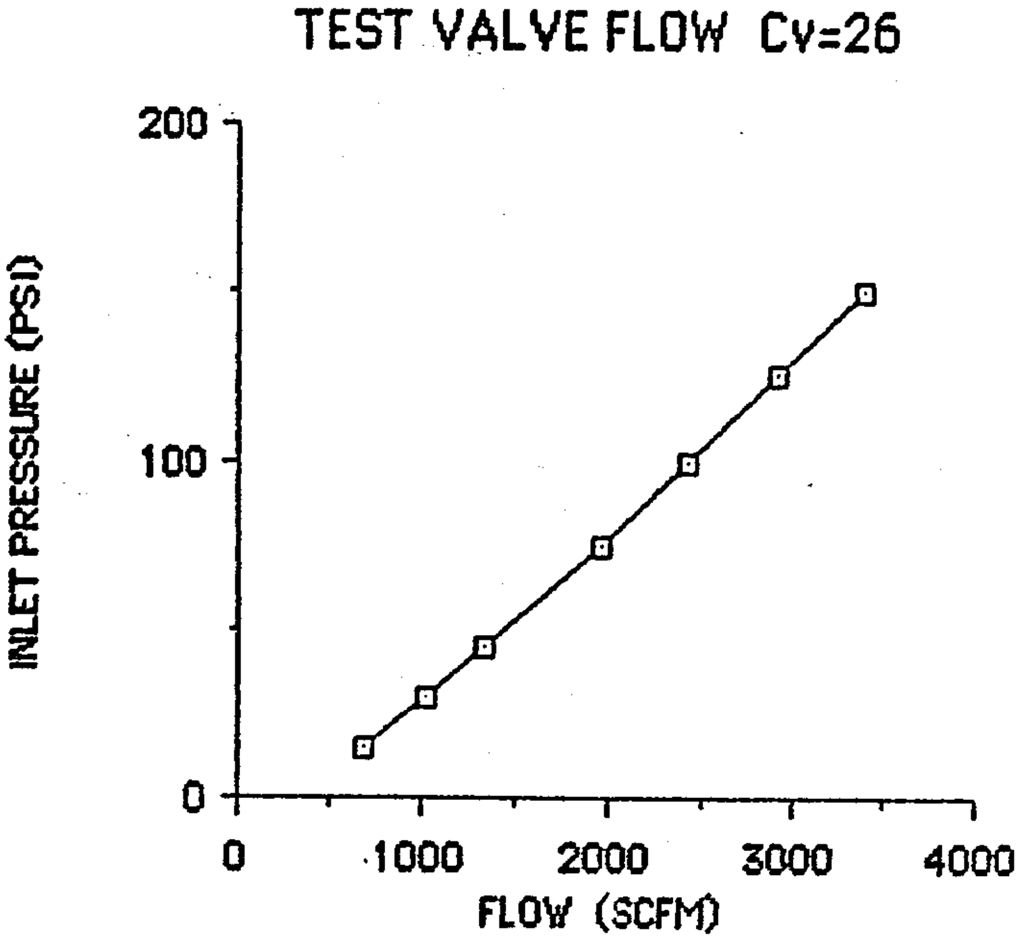
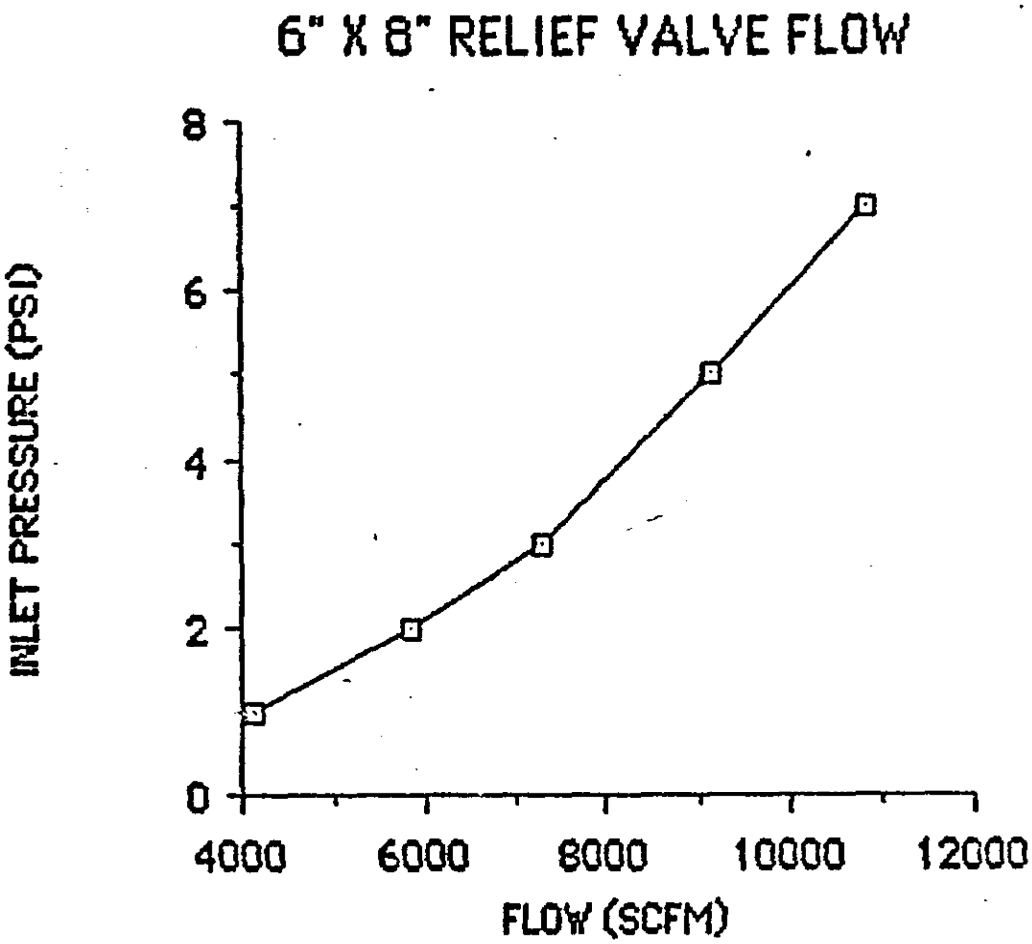

TEST VALVE FLOW Cv=26
INLET PRESSURE (PSI)
200
100
0
0
1000
2000
3000
4000
FLOW (SCFM)

Figure-1



6" X 8" RELIEF VALVE FLOW
INLET PRESSURE (PSI)
0
2
4
6
8
4000
6000
8000
10000
12000
FLOW (SCFM)

Figure-2

Fermilab

E 706

Ar VENT TESTS

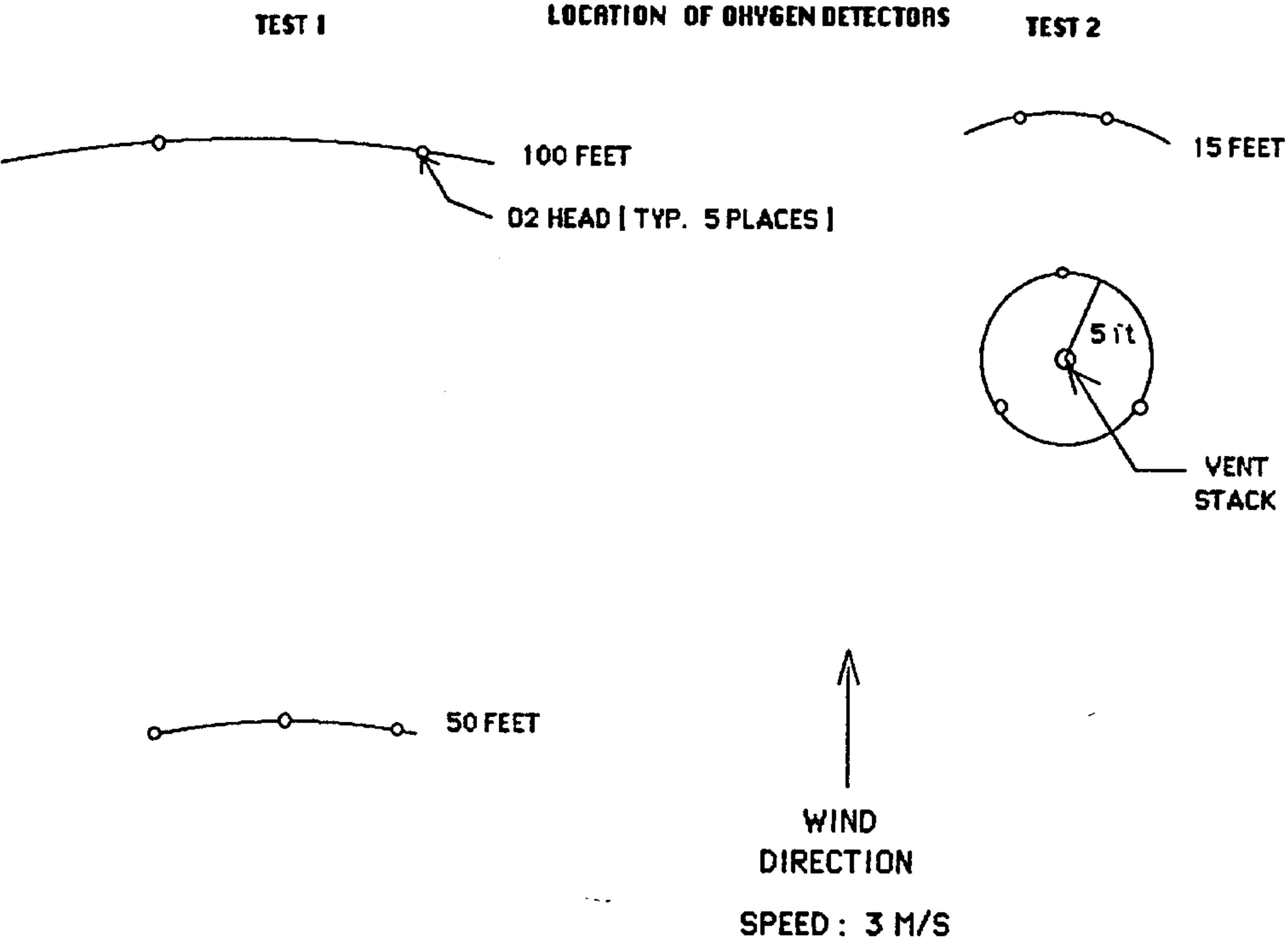
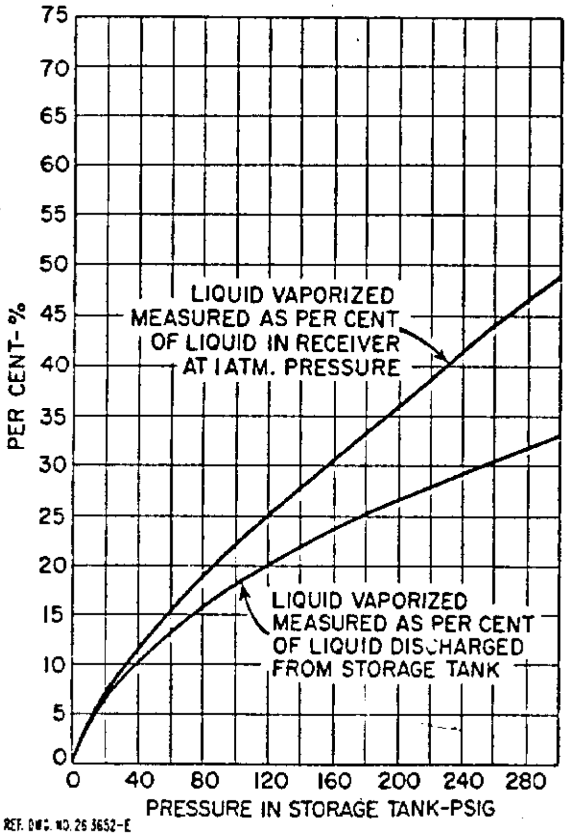


Figure-3

O VENT STACK

Vapor Release From Depressurized Liquid Argon

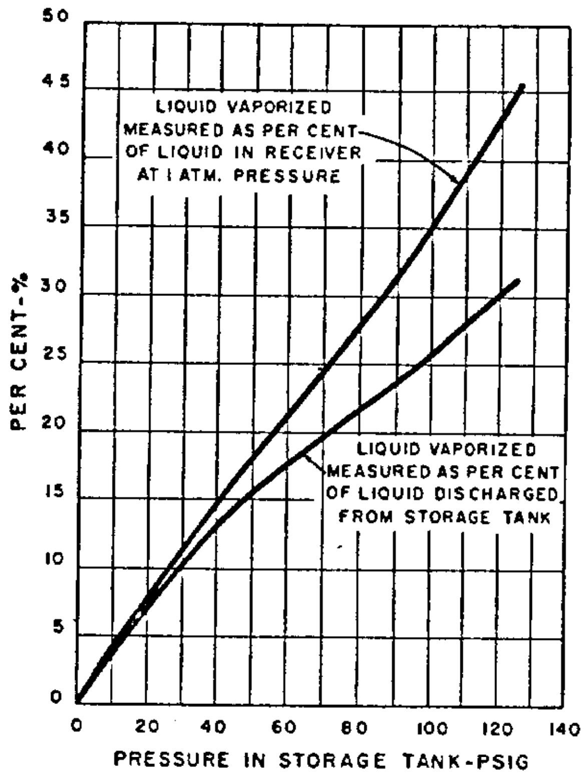
AIRCO



REF. DWG. NO. 26 3652-E

Vapor Release From Depressurized Liquid Hydrogen

AIRCO



REF. DWG. NO. 26 8852-E

figure 4

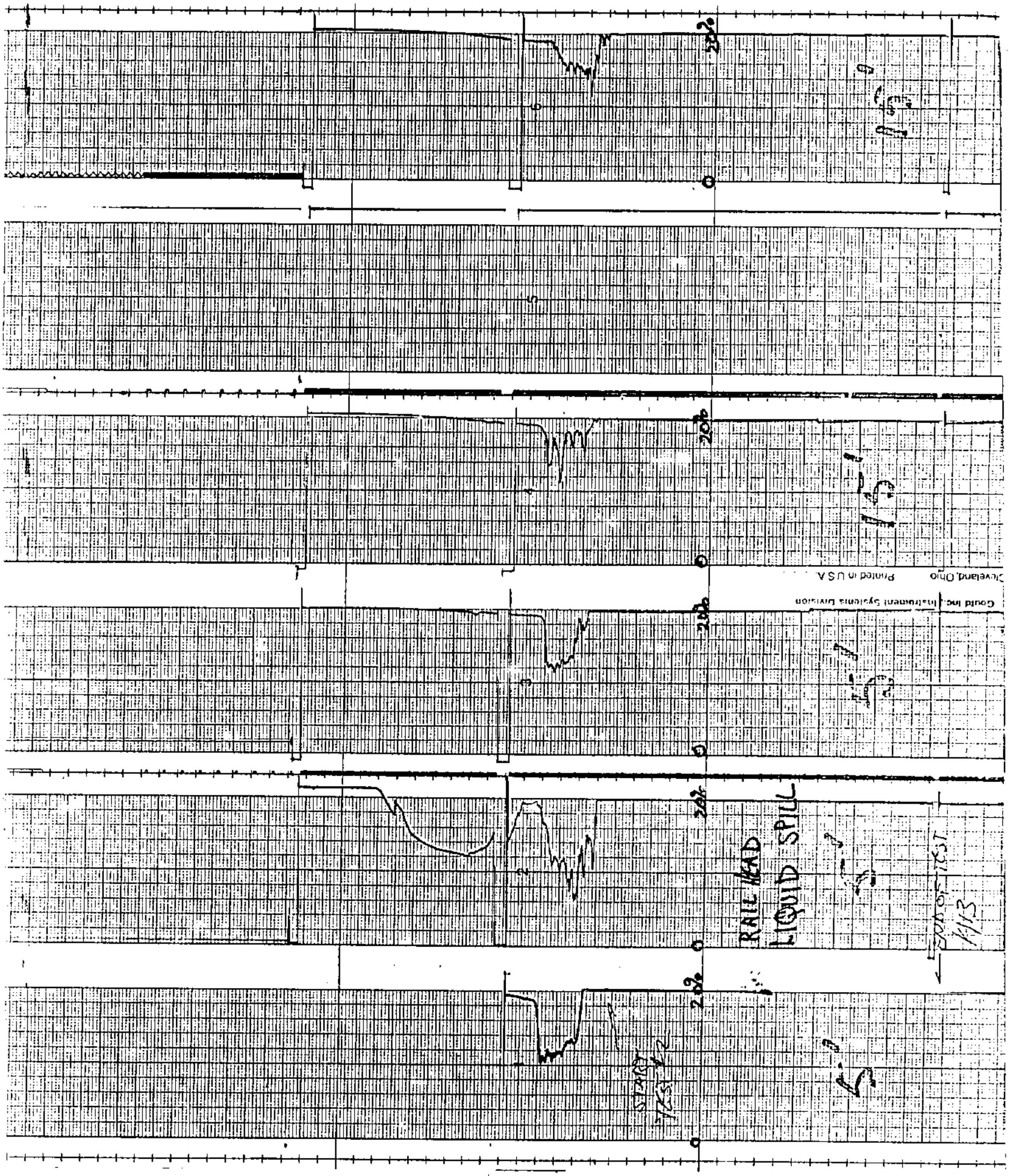
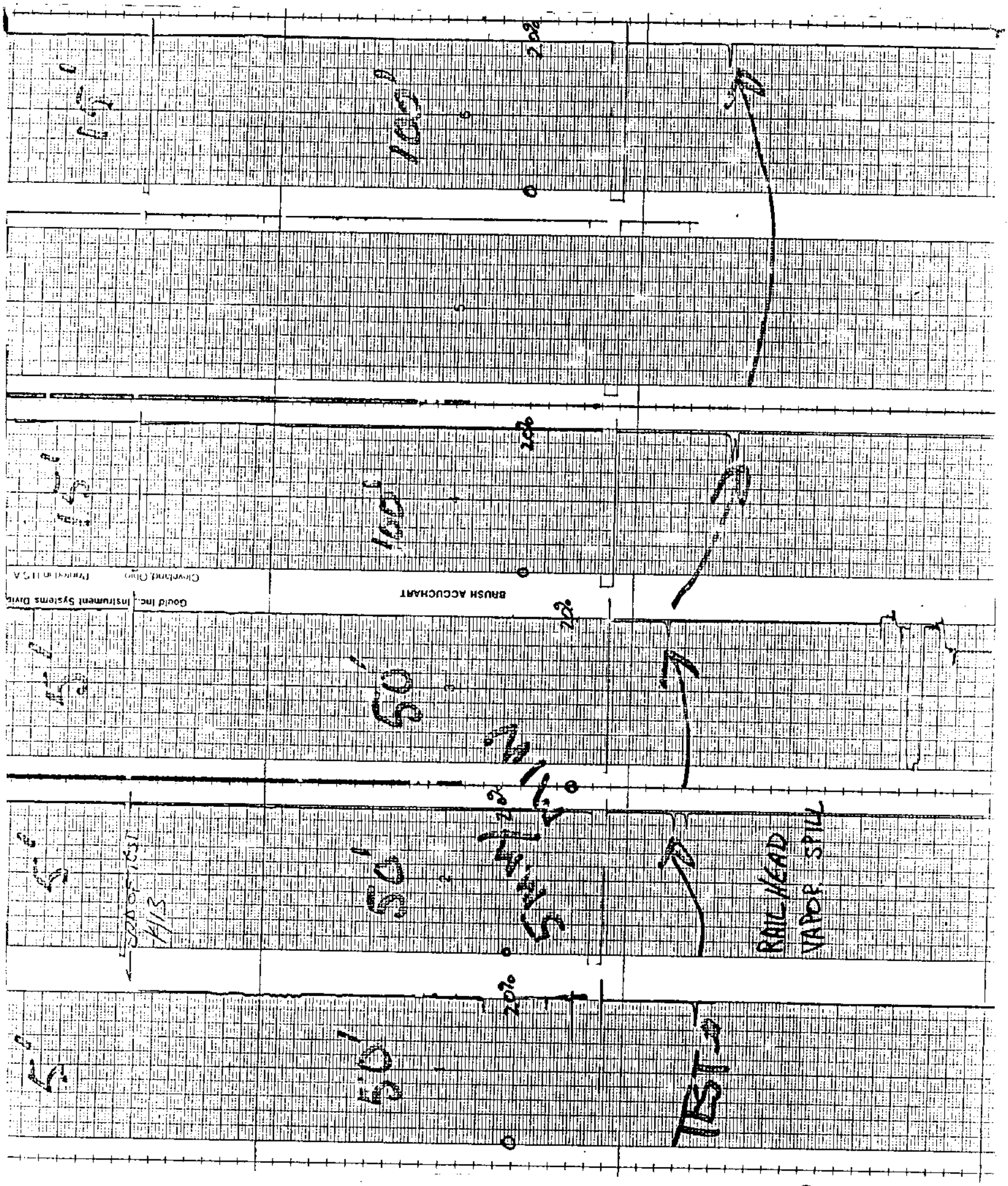


Figure 5



100'
50'
TEST
RAIL HEAD
VAPOR SPILL
BRUSH ACCUCHART
Gould Inc., Instrument Systems Divis
Cleveland Ohio

figure 6